



## Impact through Networks 2021

PLP 6701

2 credit hours

Class meetings: Tuesday and Thursday, Period 5 (11:45-12:35), 2564 Fifield Hall

Fall semester 2021, and alternate years

### Prerequisites

There are no specific prerequisites.

It will be helpful to have general knowledge of agricultural, ecological, or epidemiological systems, and experience from graduate or advanced undergraduate courses applying quantitative concepts and tools (such as courses addressing statistics, mathematics, or engineering)

### Instructors

Dr. Karen A. Garrett ([garrettlab.com](http://garrettlab.com))  
Plant Pathology, Food Systems Institute, Emerging Pathogens Institute  
Office: 2411 Fifield Hall  
Email: [karengarrett@ufl.edu](mailto:karengarrett@ufl.edu)

Yanru Xing: [yanruxing@ufl.edu](mailto:yanruxing@ufl.edu)

**Course materials access:** invitation to Teams will be provided to participants

### Office hours

By appointment in advance, 2-4 Tuesday and 3-5 Wednesday, or additional times as needed

### Course overview

Outcomes in systems such as agriculture, natural ecosystems, and health care are often determined by processes that act through networks. Networks can describe the spread of pathogens, invasive species, consumer goods, ideas, and technologies. Networks can also describe associations, interactions, and transactions among people, species, and other agents. This course addresses how to analyze the impact of system changes in networks, such as the introduction of new species or new management techniques. This course provides an introduction to network science in the R programming environment, and a review of applications in biological and social sciences, including current methods used to evaluate impact. The course includes a combination of lectures to provide background information, discussion of current literature, computational analysis workshops to illustrate concepts, and individual projects to allow participants to apply ideas to systems that particularly interest them.

The course emphasizes concepts and use of existing tools, while at the same time it will offer a basis for the development of new tools for participants interested in further steps.

### Course learning objectives

Participants who have completed this course will be able to...

- ❖ explain how networks are defined and applied in agriculture, ecology, and epidemiology
- ❖ identify and discuss key points in journal articles describing networks in these systems
- ❖ evaluate dynamic networks and study processes in networks
- ❖ explain basic principles of impact analysis in these systems
- ❖ collect data for characterizing networks that enable testing the fit of network models
- ❖ apply network analysis to ask questions about their own systems using R

### Course outline (*as of 3 August 2021 – subject to minor changes*)

Course assignments to be turned in or presented by students are indicated in bold

	<b>Tues:</b> often a short lecture and discussion of a paper	<b>Thurs:</b> often a short lecture and a workshop for network analysis in R
Aug 24, 26	First class: Course overview, and examples of what can be done with skills from this class	Intro to R, Part 1
Aug 31, Sept 2	Intro to R, Part 2	Intro to networks and matrices in R ( <b>quiz</b> )
Sept 7, 9	Epidemic networks, Part 1	Epidemic networks, Part 2 ( <b>quiz</b> ) Describing nodes in R

Sept 14, 16	Microbiome networks	Visualizing and describing networks in R, Part 1 ( <b>quiz</b> )
Sept 21, 23	Networks of association in R	Visualizing and describing networks in R, Part 2 ( <b>quiz</b> )
Sept 28, 30	Multilayer networks	Multilayer networks in R ( <b>quiz</b> ) ( <b>quiz</b> )
Oct 5, 7	Gene networks	Preparing project proposals Bayesian networks in R ( <b>quiz</b> )
Oct 12, 14	Mathematical models of networks in R	Exponential random graph models (ERGMs) in R ( <b>quiz</b> )
Oct 19, 21	Survey of other network types ('omics, economics, ecology, communication, etc.)	Preparing project proposals More mathematical models of networks in R ( <b>quiz</b> )
Oct 26, 28	Social networks	Networks and meta-populations in landscapes ( <b>quiz</b> )
Nov 2, 4	Evaluating impact in networks Value of information	<b>Proposal presentations</b>
Nov 9, 11	<b>Proposal presentations</b>	---- <i>Veterans Day: no classes</i>
Nov 16, 18	<i>Paper discussion</i>	<i>Paper discussion</i>
Nov 23, 25	<i>Paper discussion</i>	---- <i>Thanksgiving vacation: no classes</i>
Nov 30, Dec 2	<i>Paper discussion</i>	<i>Paper discussion</i>
Dec 7, 9	Participant's choice topic	---- <i>Reading days: no classes</i>
Finals week	<b>Final project presentations</b>	

## Grading

- 10% Class discussions
- 20% Weekly quizzes and assignments
- 30% Project proposal
- 10% Journal article presentation and discussion
- 30% Final project

Class discussions. When scientific papers are discussed, all participants will be expected to contribute to the discussion (even when not leading the discussion). When project proposals are presented, all participants are expected to contribute feedback for the projects. Discussions are evaluated based on a course rubric for contributing to discussions.

Brief quizzes covering recent course topics are given most weeks, to help participants keep up with the course material. The lowest three quiz scores will be dropped from the grade.

The project proposal will give students an opportunity to show how they can apply the course concepts and tools to an area of particular interest to them. The project proposal is presented in class (approximately 10 minutes per student, depending on course enrollment), and covers a topic of particular interest to an individual student, drawing on course material about network analysis. The project proposal outlines the analysis that the student will later present as the final project. The project proposal is evaluated based on a course rubric for proposal presentation.

Each participant will lead or co-lead a journal article discussion for the group. The discussion is evaluated based on a course rubric for leading article discussions.

Final projects will be presented and discussed in the class (approximately 20 minutes per student, depending on course enrollment). The final project builds on the material presented in the project proposal, including analyses of real data or simulated data provided for students to analyze when appropriate real data are not yet available. (For example, if a student is planning to collect a particular type of data in future semesters, the student could temporarily work with a similar simulated data set for purposes of this class project.) The final project is evaluated based on a course rubric for project presentation.

If the grade on an assignment appears incorrect, the process for requesting reconsideration of the grade is to prepare a written statement describing where the error lies, to be turned into the instructor within one week of receiving the grade.

Grades and Grade Points: For information on current UF policies for assigning grade points, see <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

**Grading scale:** 94-100 A; 90-93.99 A-; 87-89.99 B+; 84-86.99 B; 80-83.99 B-; 77-79.99 C+; 74-76.99 C; 70-73.99 C-; 67-69.99 D+; 64-66.99 D; 60-63.99 D-; 0-59.99 E

### **Required course materials**

There is no required textbook for this course. Journal articles for discussion will be provided to the class. The journal articles will be chosen in discussion with the participants who will be leading discussions, to represent the range of topics in the schedule above.

**Examples** of review articles and original research articles, some discussed in the class in 2017 and/or 2019, include the following:

Agler et al. 2016. Microbial hub taxa link host and abiotic factors to plant microbiome variation. *PLOS Biology* 14:e1002352.

Bensimon et al. 2012. Mass spectrometry-based proteomics and network biology. *Annual Review of Biochemistry* 81:379-405.

Chadès et al. 2011. General rules for managing and surveying networks of pests, diseases, and endangered species. *PNAS* 108:8323-8328.

Chatters et al. 2019. Analysing livestock network data for infectious disease control: an argument for routine data collection in emerging economics. *Philosophical Transactions of the Royal Society B* 374:20180264.

Cumming and Peterson. 2017. Unifying research on social-ecological resilience and collapse. *Trends in Ecology & Evolution* 32:695-813.

Dormann et al. 2017. Identifying causes of patterns in ecological networks: Opportunities and limitations. *Annual Review of Ecology, Evolution, and Systematics* 48:559-584.

Garrett. 2021. Impact network analysis and the INA R package: Decision support for regional management interventions. *Methods in Ecology and Evolution*.  
<https://doi.org/10.1111/2041-210X.13655>

Garrett et al. 2018. Network analysis: A systems framework to address grand challenges in plant pathology. *Annual Review of Phytopathology* 56:559-580.

Gaudinier and Brady. 2016. Mapping transcriptional networks in plants: data-driven discovery of novel biological mechanisms. *Annual Review of Plant Biology* 67:575-594.

González-Mon et al. Small-scale fish buyers' trade networks reveal diverse actor types and differential adaptive capacities. *Ecological Economics* 164:106338.

Henry and Vollan. 2014. Networks and the challenge of sustainable development. *Annual Review of Environment and Resources* 39:583-610.

Kramer et al. 2016 Spatial spread of the West Africa Ebola epidemic. *Royal Society Open Science* 3:160294.

Kuzmin et al. 2018. Systematic analysis of complex genetic interactions. *Science* 360:6386.

Layeghifard et al. 2017. Disentangling interactions in the microbiome: A network perspective. *Trends in Microbiology* 25:217-228.

Luke and Harris. 2007. Network analysis in public health: History, methods, and applications. *Annual Review of Public Health* 28:69-93.

Luke and Stamatakis. 2012. Systems science methods in public health: Dynamics, networks, and agents. *Annual Review of Public Health* 33:357-376.

McGillivray et al. 2018. Network analysis as a grand unifier in biomedical data science. *Annual Review of Biomedical Data Science* 1:153-180.

Mello et al. 2019. Insights in the assembly rules of a continent-wide multilayer network. *Nature Ecology & Evolution* 3:1525-1532.

Parrat et al. 2016. Infectious disease dynamics in heterogeneous environments. *Annual Review of Ecology, Evolution, and Systematics* 47:283-306.

Shaw and Pautasso. 2014. Networks and plant disease management: Concepts and applications. *Annual Review of Phytopathology* 52:477-493.

Shi et al. 2016. The interconnected rhizosphere: High network complexity dominates rhizosphere assemblages. *Ecology Letters* 19:926-936.

Tylianakis and Morris. 2017. Ecological networks across environmental gradients. *Annual Review of Ecology, Evolution, and Systematics* 48:25-48.

### ***Good references***

For network analysis in R, both of the following books are good references. It's recommended that course participants use at least one of these two books as a reference.

1. This one takes more of a statistical perspective, with more careful mathematical definitions and denser information:

Kolaczyk and Csárdi. 2020. *Statistical Analysis of Network Data with R, Second Edition*. Springer.

2. Luke writes from the standpoint of experience in public health applications, aimed more toward non-statisticians:

Luke. 2015. *A User's Guide to Network Analysis in R*. Springer.

Participants might be interested in the following book for reference, which provides much more information about general network applications than will be covered in this course:

Newman. 2018. *Networks, Second Edition*. Oxford University Press.

The following is a good reference on social networks, authored by UF's own Jeffrey C. Johnson:

Borgatti, Everett, and Johnson. 2018. *Analyzing Social Networks*, Second Edition. Sage Publications.

A good reference for data science in R is the following, with a lot of good information available at <http://r4ds.had.co.nz/>

Wickham & Grolemund. 2017. *R for Data Science*. O'Reilly.

A good general reference for R, though a little old, with many examples of statistical analysis:

Crawley. 2012. *The R Book*. Wiley.

### **Garrett's teaching philosophy**

I think of teaching as a process that occurs in a network (of course). An individual could create a pretty good learning experience by finding a good set of books and papers on a topic, and trying out some R code on their own. However, this course is designed to offer a fuller experience and more efficient learning by linking participants to key literature, to relevant R packages, and to each other and the instructors through discussions and feedback. Engaging with a group of people interested in a topic can also be a lot of fun and boost creativity.

The course is designed to support participants in engaging with projects, rather than emphasizing testing. The quizzes are intended to provide some structure to help keep participants up to date and engaged in the discussions. Most of the course activities will engage knowledge and creativity in developing projects. The teachers will work to help each student develop a project that they will find useful in their current or future research.

### **Attendance and make-up policies**

This is a synchronous course, to make the most of interactions among participants. Discussion among course participants is an important part of the learning experience, so attendance is required. Three course meetings can be missed without explanation (with the exception of dates when the participant has a particular responsibility, such as leading discussions or presenting). Please alert the instructor if there is a serious health problem or other emergency.

Requirements for class attendance and make-up exams, assignments and other work are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

### **Accommodations for Students with Disabilities**

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students should first register with the Disability Resource Center at 0001 Reid Hall, 352-392-8565, [www.dso.ufl.edu/drc/](http://www.dso.ufl.edu/drc/) and provide appropriate documentation.

### **Recorded class sessions**

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

### **On-line course evaluation**

For this course, we will also ask students to anonymously provide some more specific recommendations for making the course as useful and interesting as possible, in both a mid-term survey and a final survey. This will be in addition to the general UF course assessment.

UF Policy: Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>

### **Materials and supplies fees**

None

### **UF Policy on Academic Honesty**



As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity." You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>.

## **UF Policy on Software Use**

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

## **Campus helping resources**

The university's counseling resources are available for students experiencing personal problems that interfere with their general well-being and/or academic performance. The Counseling & Wellness Center provides confidential counseling services at no cost for students that are currently enrolled with the university.

- University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, [www.counseling.ufl.edu/cwc/](http://www.counseling.ufl.edu/cwc/)
  - Counseling Services
  - Groups and Workshops
  - Outreach and Consultation
  - Self-Help Library
  - Training Programs
  - Community Provider Database
  
- Career Resource Center, First Floor JWRU, 352-392-1601, [www.crc.ufl.edu/](http://www.crc.ufl.edu/)

## **Student complaints**

If there is an issue in the course, please bring it to the instructor's attention. UF policies about more serious complaints are described in these documents.

- Residential Course: [https://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf)
- Online Course: <http://www.distance.ufl.edu/student-complaint-process>